Damage Tolerance Assessment of Friction Pull Plug Welds in an Aluminum Alloy

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Friction stir welding is a solid state welding process used in the fabrication of cryogenic propellant tanks. Self-reacting friction stir welding is one variation of the friction stir weld process being developed for manufacturing tanks. Friction pull plug welding is used to seal the exit hole that remains in a circumferential self-reacting friction stir weld. A friction plug weld placed in a self-reacting friction stir weld results in a non-homogenous weld joint where the initial weld, plug weld, their respective heat affected zones and the base metal all interact. The welded joint is a composite plastically deformed material system with a complex residual stress field. In order to address damage tolerance concerns associated with friction plug welds in safety critical structures, such as propellant tanks, nondestructive inspection and proof testing may be required to screen hardware for mission critical defects. The efficacy of the nondestructive evaluation or the proof test is based on an assessment of the critical flaw size. Test data relating residual strength capability to flaw size in an aluminum alloy friction plug weld will be presented.